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VOL. XL, No. 2 FEBRUARY, 1946 WHOLE No. 351

THE STARS AND YOU*

By DANIEL P. GILLMOR

VERY few things in nature are more neglected than the stars. Now and again on fine nights, we take a glance upwards and say to ourselves, what a wonderful night it is, and then go on our way thinking of something else. How often have you heard people say that they wished they knew constellations and the names of some of the stars and yet they do nothing about it?

The main reason for this neglect is that the average person is frightened away from the study of astronomy because of his idea of the mathematics involved. Relativity, Einstein's theory, and formulæ rise up in the mind's eye and form an insurmountable barrier to the romantic, engrossing story of the stars.

Such an attitude is perfectly natural and normal. Very few of us can have any fun with compasses, slide rules and logarithms. In fact, I have never been able to define my feelings towards those who enjoy such things, as one of envy or of pity, but we will let that pass. The astronomer is looked upon as a musty old gentleman with a long beard, wearing a pointed hat, covered with cabalistic drawings. Nothing could be further from the truth. The astronomers of to-day are up to date, smart appearing gentlemen, whose keen minds are reflected in their lineaments. Look at photographs of Jeans, Shapley,

*An address before the Montreal Centre, October 25, 1945, by the Retiring President of the Centre.

Eddington and Hubble. If you wish to see a bearded astronomer of recent times, look at the picture of Edward Charles Pickering, the Founder of American Variable Star Astronomy; there is nothing musty about him, I can assure you.

The heights of astronomical attainment have not been treaded by only masculine feet. Observe some of the ladies, who have turned their eyes skyward, and I have no doubt in your agreeing with me when I say that an evening spent with some of them without benefit of telescope would not be an evening misspent.

There is, strange to say, confusion in the public mind between astronomy and astrology. Perhaps as good a way as any to dispel this misconception is to define an astrologer as an astronomer gone wrong. Astrology is usually a scheme on the part of some people, who have a certain knowledge of the stars, to separate the uninformed and gullible from their money by telling them their past, present and future, according to the position of various planets, etc., at the time of their birth, etc. Let us nail the astrological hide to the barn door right here and now by quoting Section 443, of the Criminal Code, which reads,

"Every one is guilty of an indictable offence and liable to one year's imprisonment who pretends to exercise or use any kind of witchcraft, sorcery, enchantment or conjuration, or undertakes to tell fortunes, or pretends from his skill or knowledge in an occult or crafty science, to discover where or in what manner any goods or chattels supposed to have been stolen may be found."

One Judgement reads as follows:

"Offering by advertisement in newspapers to cast nativities and answer astrological questions, and pretending by circular letter, in return for certain remuneration, to give a description of the person, liability to disease, occupation most suitable, marriage, etc., by the position of the planets at the nativity, was ample evidence that appellant had pretended to tell fortunes, without proof that he had actually told anybody anything."

My advice to you, which is as practical as it is sincere, is that you be not frightened off from the study of astronomy by the formulæ involved in the mathematical aspect of the science. Take the findings of the mathematician for granted, the same as you do not inquire into the problems of electricity when you turn on an electric light, or the problems of the clock maker when you look at your

watch. You can get along without them. You do not need to know how to measure the distance from the earth to the sun, or the earth to a distant star. Take the opinion of the experts in such matters that a distance is so many astronomical units, light years, or parsecs. Get a rough idea of what these measurements are and let it go at that. You will never need to make them any more than you will have to measure the distance from here to Ottawa, should you want to go there. The problems of astro-physics, which has told us so much of the composition of the stars, you do not need to study at all. I remember when I first became interested in astronomy, the term the "precession of the equinox", gave me a gone feeling in my tummy. Later on, when I found out that it was really a wobble of the earth, turning around its axis, the term held no further terrors for me. There are a few simple laws which are easily understood and easily remembered and a little mental exercise will do us all good, for there is no royal road to learning.

Some, who take up astronomy, immediately set about to buy, or make a telescope. If you have sufficient money or the necessary mechanical aptitude, this is all very well. It is a lot of fun to grind a mirror, and rig it up. I should imagine that it would be a great feeling to be able to buy and set up a brand new shiny telescope for one's self, but when you can't afford to buy, and don't know how to make a telescope, you can get along very well without one. One thing about amateur astronomers is that they are always willing to lend a helping hand, and to let you look through their instruments.

A lot of work is done by photography, but you don't need to buy an astronomical camera. Once you get interested in the stars, you will start reading books about them and in these, you will find photographs of every section of the sky.

Much is learned from the use of the spectroscope. A ray of light from a star, billions of miles away, is focused through a telescope and a spectroscope. The resultant spectrum is photographed there available for your use, an image which will tell you things about that star that you never thought it possible for human beings to know. These photographs are in the books. There for your convenience

is the work of the experts.

Even if you never looked at a star, the romance of their study and the progress made by man, in his insatiable quest for knowledge is as gripping as the modern mystery story. Start back with the ancients, and their ideas of the universe. With the earth at its centre and the various stars and constellations fixed in solid revolving spheres. Reflect on how they noticed that certain stars move together in groups, which they call constellations, and how the outlines of these prompted the imagination of these early star gazers to couple them with the figures of mythology and of animals, birds, etc. The planets Mars, Jupiter, Venus, and the constellations Perseus and Andromeda, Hercules, the Lion, the Bear, the Crab and the Swan. All these and more, are names which go back into the dimmest recesses of antiquity. Many of the celestial imaginings have been reduced to paintings of exquisite beauty by the old masters.

Follow the progress of liberal thought through the studies and observations of Galileo and Copernicus. The very names of these and other giants such as Tycho Brahe, Kepler, Newton and the Herschels spell romance and inspire inquiry. Then there are the stories of the discoveries of the planets, Uranus, Neptune, and Pluto. These are epics in themselves.

Herschel discovered Uranus. He did not know that it was a planet and was not quite sure that he could find it again. The story goes that on a certain night he was to show it to Queen Caroline. He was not quite sure that the star would be there to be shown, so he protected himself from failure by boring a hole in a fence and having a confederate behind it with a candle, in case the new star did not appear. Uranus was discovered by observation. Neptune was discovered by pure mathematics, worked out by Adams in England, and Leverrier in France. From their calculations the prediction was made that a planet would be at a certain spot in the sky on a certain night in September, 1846. In exactly half an hour after the commencement of the search, the planet was located. In 1915, Lowell from his mathematical investigations plotted an orbit for a new

planet, and 15 years later, Pluto was discovered by means of photography. Some astronomical opinion seems to be against the fact that Pluto was the planet predicted by Lowell. We might stretch the point in his favor.

I wish that Mr. Lowell could be given the benefit of the doubt. The orthodox astronomers so attacked the results of his observations of the canals on Mars that in this instance, he might be treated a little more kindly. This same person, Lowell, was a wealthy gentleman who became interested in the stars. He determined to build an observatory for his own use, and intended to have it situated in the best location on the earth available for an observatory. He searched in Japan, Maritime Alps, Algeria, Mexico and California, and finally decided on the Flagstaff Plateau in Arizona. There is an example of enthusiasm and tenacity of purpose. The practical minded will say however, "That is all very well, Lowell and others like him can spend their money, can look at the sky, map it, photograph it, but what is the good of it all, of what use is it?"

It must be admitted that it is difficult to give clear cut definite examples of the uses of astronomy. Follow me while I enumerate some of the most outstanding. Our everyday routine, the seasons of the year, and the years themselves, as arranged on our calendar, are based on astronomy. Back in 4236 B.C., the Egyptians adopted a calendar based on the rising of Sirius, the Dog Star. This star would remain invisible for several days, and then would first reappear on the eastern horizon just before the rising of the sun. They calculated that this occurred regularly after successive intervals of 360 days and founded a calendar accordingly.

The human family has used many calendars since then and the progress of astronomical knowledge has shown us that the earth makes a full course of its orbit in 365 days, 5 hours, 48 minutes, 46 seconds. Our present calendar is arranged accordingly.

Not only is the period of the year calculated by the astronomer, but the exact time during the day is also given to us by the same gentleman. It will surprise many to know that there are three different times. Apparent time, as given by the Sun Dial. Mean time,

because Apparent time is not constant, and Sidereal time, which is computed when a given star is on the Meridian.

The story of time is an engrossing one. When you get the time signal on the radio from the Dominion Observatory at Ottawa, you are directly benefiting by observations and calculations made by generations of astronomers. It is this exact scientific time which regulates the time of trains, buses and other vehicles of travel, and for this, we are indebted to the astronomer.

In its ultimate analysis, it is the observation of an astronomer which fixes the exact boundaries of your real estate. When you cross the ocean, or make a trip in a boat, it is by means of astronomy that your position and course are determined. Helium gas, it is astounding to relate, was discovered first in the sun and then searched for and located on the earth. This was the result of the examination of spectroscopic photographs of the sun.

Variations in the numbers of the spots on the sun is believed to be accountable for the rise and fall in the numbers of mice and other small rodents. There are spots, which are visible on the sun's surface. Sometimes there are more than others. And a direct relationship between these, and the numbers of these small animals is believed to have been established.

It is difficult, as I said before, to give concrete examples, but it may be said without contradiction that astronomical studies have been the cause of much progress in other sciences. Who can say where the results of man's investigations of the heavens stopped? Galileo devised the telescope for the purpose of bringing the stars closer. Think how the principle of the telescope has been used by man in his march of progress. Your opera glasses, your camera, your reading glass, the microscope which has assisted man so much in his battle against disease, and in the exploration of the tiny universe within a drop of water, all these go back to the genius of Pisa.

With the telescope, the camera and the spectroscope, man has searched the heavens and plumbed the depths of space. Is the electric clock on the wall outside this room, and the watch on your wrist, the outcome of the thoughts of the first Egyptian, who watched

the rising of Sirius some six thousand years ago? I leave it to you to form your own opinion. Was the determination of the speed of light the outcome of an astronomer's question? I would not like to have to prove the negative. The science of physics and astronomy are closely intermingled. At times it is difficult to say where one ends, and the other begins. Be that as it may, think of the impetus given to man's intellectual powers by curiosity regarding the stars and the universe around him. Starting with the first man who looked up and wondered, consider the strides which man's intellect has made. The universe has been measured, mapped and weighed. Our sun has been found to be one star in many millions, forming what is known as a galaxy. The average galaxy is roughly speaking in the shape of a cartwheel, and our sun is situated approximately one-half way through and about one-third of the way off centre. These galaxies are numbered in the millions. Can you bring your mind to bear on such a concept? Millions and millions of stars in each galaxy, and millions of galaxies. Our sun, a comparatively small star, in one of these galaxies, and our earth, a small satellite of the sun. The enumeration of these galaxies is proceeding. The idea of an expanding universe is neither denied, nor confirmed in the minds of our giants of thought. Not only have distant stars been weighed and measured, but the star stuff of which they are composed, has been analysed. The temperatures and specific gravity have been reduced to scientific tables and all this the mind of man has done. Do you still ask what good is astronomy? Are you yet in accord with Edwin Arnold, who said that "Astronomy will eventually be the chief educator and emancipator of the human race."

Do not think that all astronomical questions have been answered. There is plenty of interesting work for any of you to do. There are still questions to be answered and varying opinions to be reconciled. Some of these are as follows:

Are the craters on the moon formed by volcanic action, or are they made by the impact of meteorites?

Are there traces of an atmosphere left in some of the craters of the moon?

What is the composition of the atmosphere of Venus?
What is the origin of the earth and the other planets of the sun?

These are questions which just come to my mind off-hand. There are a myriad others. Do not throw up your hands at the seeming magnitude of these tasks. It won't take you long before you will have some sort of an opinion of your own, then you can go to work to prove it.

Besides solving these and other problems, there are many wondrously beautiful things which you can observe in the skies. Examine the mountains on the moon. An ordinary pair of opera glasses will suffice. Take a piece of smoked glass and watch for spots on the sun, these spots, which are whirling vortices of incandescent gases, unbelievably hot, and pitting the surface of the source of our light. On the edge of the sun are huge flames of gas called prominences which shoot up into space hundreds of thousands of miles, linger there, change their shape, and dissipate. There are the little moons of Jupiter, or Mars and of most of the other planets. Saturn has nine of these little fellows, in addition to the rings. You can watch for comets. Without the aid of a telescope, you can look for meteors. With telescopes you can observe the pulsating stars sometimes called novæ, some of whom vary in size and brightness a million fold. All these wonders of the heavens are there waiting for you to notice them, should you be so minded.

Often, I have heard it said that this scientific knowledge of the stars detracts from their romance and beauty. Make the observations which I have just outlined and you will find that the stars take on a new romance, a new beauty and an additional appeal. No one knows everything about the stars. Even Jeans, Shapley and Einstein, himself, can look up at any of the points of light which dot the heavens and say, "Twinkle, twinkle, little star how I wonder what you are."

But the main benefit and the greatest good which you will derive from astronomy is what it will do for you. Your understanding of the world's great literature will be broadened. References to the stars by name will take on new meanings for you. In fact, you can-

not properly understand the world's masterpieces without a slight acquaintance with individual stars and constellations. Homer abounds with references and at the same time, in Homer you learn of the Olympian gods and find the stories from which the names are derived.

> "Aurora now, fair daughter of the dawn,
> Sprinkled with rosy light the dewy lawn;"

Aurora was the Goddess of the Dawn. Boreas was the son of the River God, Strymon. The north wind was named after him, and the word also meant, "the thing from the Mountain." The north wind came from the Mountain, and hence the north wind so gets its name. The next time you see the northern lights think of the centuries of poetry, behind their name Aurora Borealis.

Take another line from the *Iliad*,

> "Now flaming from the zenith,
> Sol had driven his fervid orb through half
> the vault of heaven;"

Has ever passage of an afternoon been more exquisitely described? I cannot resist one more reference to the dawn.

> "Soon as Aurora heaved her Orient head
> Above the waves, that blush'd with early red
> (With new-born day to gladden mortal sight,
> And gild the courts of heaven with sacred light),"

Some of the most beautiful references to the stars are found in Holy Writ. What grander concept could be expressed than the Nineteenth Psalm? The pages of Shakespeare, Milton, Tennyson and all our poets are spangled with stellar references. How much more these mean to us when we know the star or constellation of which the poet sings. Let me read you some lines from Marlowe. I wish I could read you his plays.

> "Black is the beauty of the brightest day;
> The golden ball of heaven's eternal fire,
> That danc'd with glory on the silver waves,

> Now wants the fuel that inflam'd his beams;
> And all the faintness, and for foul disgrace,
> He binds his temples with a frowning cloud,
> Ready to darken earth with endless night.
> Zenocrate, that gave him light and life,
> Whose eyes shot fire from their ivory brows,
> And temper'd every soul with lively heat,
> Now by the malice of the angry skies,
> Whose jealousy admits no second mate,
> Draws in the comfort of her latest breath,
> All dazzled with the hellish mists of death.
> Now walk the angels on the walls of heaven,
> As sentinels to warn the immortal souls
> To entertain divine Zenocrate:
> Apollo, Cynthia, and the ceaseless lamps
> That gently look'd upon this loathsome earth,
> Shine downwards now no more, but deck the heavens
> To entertain divine Zenocrate:"

It is not likely that many of you have been knocked out in a boxing match or some other form of athletics. If you have, you will remember the feeling upon returning to consciousness of wanting to orient yourself. This feeling is expressed in the well known question, "Where am I?" The same question presents itself to us as we begin to become aware of life and our surroundings, and tonight I repeat the question, "Where are we?" We have the earth under our feet, and around us is the illimitable void of the universe. I say to you that if you wish to have a proper understanding of yourself in the scheme of things, get familiar with the earth, through a working knowledge of geology, and then look to the stars. You will learn the vastness of space, and the proportion of time which is allotted to you. You will marvel at the work of the Divine Mathematician but, most of all, you will acquire a respect for the dignity of man, based on his intelligence, that intelligence, the driving spirit of which has led man's studies from the heart of the atom to the outermost ends of space. Or as Marlowe puts it,

> "Nature, that fram'd us of four elements
> Warring within our breasts for regiment,
> Doth teach us all to have aspiring minds:

Our souls, whose faculties can comprehend
The wondrous architecture of the world,
And measure every wandering planet's course,
Still climbing after knowledge infinite,
And always moving as the restless spheres,
Will us to wear ourselves, and never rest,"

For nineteen centuries at least, man has been seeking to know the will of God. Unfortunately, the will of God has too often been defined as what we wish it to be. It is my conviction that the physicist, the chemist, the biologist, the geologist and the astronomer with their incessant inquiries have pointed out to us with the prophets and seers of the past, the road which the Creator has ordained that we follow.

To-day the path of the comet can be traced in its approach to the sun and its departure into the cold, lonely voyage beyond our system. As it glows, and fades in the distance, we can follow it with precision. We know where it will be and when. Some day we will know why.

Be not disturbed by the fallacious idea that science and religion will not mix. They go hand in hand. Jean Jacques Rousseau said, when looking at the gloriously blazing heavens of the night, "that I would rather believe all the fables of antiquity, than that this Universe is without a Maker," and I say, "Look to the stars, thou skeptic."

A star appeared in the heavens at the birth of Our Lord. You can study astronomical records and history to determine to your own satisfaction, if you wish, whether this star was Venus, Halley's Comet, some other comet or a Nova. The study of such a question would be interesting and engrossing. But let us remember tonight that for us as astronomers, the principal moral to be derived from the story is that the three wise men, three astronomers, saw the star and followed it to the Manger, wherein lay the Prince of Peace. I maintain that if you follow your studies of the stars, you may see more clearly the outlines of the face of God.

It is said that the Universe is expanding, and will become tenuous to the point of dissipation, that each star, planet and celestial object is radiating away its energy and that all force will become

obliterated in a dead level of nothingness; in other words, the universe is running down. Be this as it may, the Creater put things where they are for his purpose. The mind of man is exploring everything to ascertain that purpose, and upon the attainment of this knowledge, the soul of man will have arrived at its destiny. And you are part of the soul of man.

> "The Stars shall fade away, the sun himself
> Grow dim with age, and Nature sink in years;
> But thou shalt flourish in immortal youth,
> Unhurt amidst the war of elements,
> The wrecks of matter and the crash of worlds."

Montreal, P.Q.

THIRTY-FOURTH ANNUAL MEETING OF THE A.A.V.S.O.

By D. W. Rosebrugh

WITH the coming of peace the A.A.V.S.O. annual "get-together" held at the Harvard Observatory, October 5 and 6, 1945, began to draw a larger and more cosmopolitan attendance. Members were present from as far west as Wisconsin; and when Messieurs Paul-H. Nadeau, Charles A. Giroux, Lionel Gallichan and Roland Cusson, of the Quebec Centre, R.A.S.C., arrived after a 450-mile automobile journey it was apparent that conditions were fast on their way towards normalcy.

Mr. Leon Campbell's Fourteenth Annual Report as Recorder showed that 34,000 observations had been submitted by members during the year, which was 2,500 above the war-time nadir of 1943. Of these observations six Canadian observers contributed 1,427. From South African observers 4,577 observations were received, 3,496 of them from Mr. de Kock, without whose untiring efforts our records of southern variable stars would be very incomplete.

Among the variable stars which received special comment by the Recorder were 191300, Nova Aquilae 1945, which reached about 7th magnitude late in August and has dropped to the 11th magnitude since then; SS Cygni which has been undergoing a maximum about every 30 days as compared to about 90 days a year or two ago; and R Coronae Borealis, which dropped a magnitude and a half in brightness late last winter but which is now (October 6) at normal brightness of 6th magnitude.

Mr. C. A. Federer, Editor of *Sky and Telescope*, made a plea for accurate determinations of the times of minima of Algol, since the observations of Mr. Seely, retiring president, and Mr. Rosebrugh, retiring secretary, made during the winter of 1943-1944 had been uncertain by a number of minutes.

Those elected to the Council for the first time were: Mr. R. N. Buckstaff, Oshkosh, Wisconsin, and Mr. Neal J. Heines, Paterson, N.J. Officers elected were Dr. Charles H. Smiley, Brown University, President, Dr. Marjorie Williams, Smith College, First V.P.,

Mr. D. W. Rosebrugh, Second V.P., Mr. Herbert M. Harris, Portland, Maine, Secretary, Mr. Leon Campbell, Harvard Observatory, Recorder, and Mr. Percy W. Witherell, Jamaica Plain, Massachusetts, Treasurer.

Dr. Alice H. Farnsworth made a plea for more occultation observers. Computers are not needed at present as Greenwich Observatory is doing the computing for the entire world, but observers are.

Mr. James J. Neale, New Haven, Connecticut, stated that he had been able to secure accurate occultation observations at the bright limb of the moon, by observing in twilight hours, when the irradiation from the moon is not as troublesome as it would be in a dark sky.

Mr. Neal J. Heines, Chairman of the Solar Division, reported that the sun-spot counts submitted by A.A.V.S.O. members had proved of great value to the Carnegie Institution and to the Weather Bureau. Mr. H. Helm Clayton, former chief of the Weather Bureau in Argentina, presented an illustrated paper upon his researches, which, it was felt, showed conclusively that variations in the sun's activity, as measured perhaps only approximately by sun-spot counts, had a profound effect upon the weather, not only of the world as a whole, but upon specific localities. The existing practice of weather forecasting is, he said, to consider that the sun's radiation is constant and that the irregularities of the earth's surface, the earth's motions and the loss of heat by the earth to space "make the weather" and all its vagaries. It seems, now, however, that the variations in the sun's radiation may have more to do with the short and long term irregularities in the weather than was formerly realized. He considered that sun-spot counts give a truer picture of the sun's activity than the total area covered by spots, because, for instance, ten spots widely spread over the sun certainly indicate more general solar activity than does one large spot, even though it may have as much area as all the ten separate spots put together, because one spot, be it ever so large, only indicates solar activity at one point of the disc. He felt that, at least for continuity's sake, the old Zurich sun-spot numbers and their continuation into the present day, should be the standard.

A paper by Dr. James Bartlett on the Granulation of the Sur-

face of the Sun was read. Mr. Bert J. Topham of Toronto is assisting in this research.

Dr. Joseph P. Ashbrook showed a light-curve of Nova Vulpeculae 1670, based upon observations made by the monk Anton, in Dijon, France. This star rose to 2.5 magnitude in 1670 and then disappeared, for good. Steavenson of England has tried to locate this old nova by searching for a star with an O-type spectrum, in the location of Nova Vulpeculae 1670, but has found nothing there but a star with an F-type spectrum, which it is considered is not likely to be the old nova. No other nova is known with two rises to approximately equal maxima as widely spaced as a year apart. It is considered unlikely that two near-by novae a year apart caused this apparition.

Mr. Rosebrugh showed a light-curve of his observations of R Coronae Borealis during its first 1945 drop in brightness. Observations made by binocular showed a drop from 6.0 to 7.2 magnitude while observations made by celestial refractor showed a larger drop from 6.0 to the 7.7 magnitude. Discussion indicated that while there are many possible reasons for differences between observations made by binoculars and celestial telescopes the specific causes are not known and their effects are largely unpredictable. These discordant results are disturbing because they indicate how difficult it is to get accurate and consistent results as between different instruments and different observers. For instance, the observations submitted to the A.A.V.S.O. Recorder of Nova Herculis 1934 made in the spring of 1935 were discordant; some of these were made by binocular, some by telescope, and this may be the source of the discrepancy. A somewhat similar effect was noticed in the observations made on Nova Puppis 1942 in the spring of 1943 when the writer and one or two other observers using binoculars estimated Nova Puppis at about 6.5 magnitude while observers more favorably placed in the southern hemisphere made it a magnitude or so fainter. The discrepancy may have been caused by atmospheric causes or it may have been instrumental.

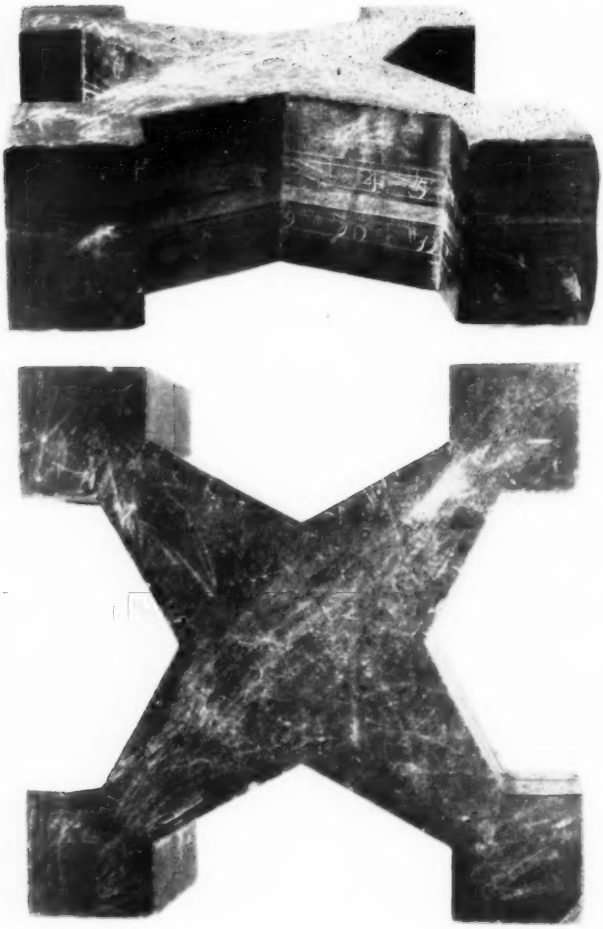
Mr. Cyrus F. Fernald, Wilton, Maine, who made 7,216 estimates of the brightness of variable stars during the last twelve months, thus

establishing an all-time high both for number and accuracy of observations, described his observing equipment. This consists of an 8-inch reflector on a Springfield mount. With this mounting the eyepiece is always stationary and one looks down into it in the direction of the south pole of the earth. Setting circles are immediately adjacent to the eyepiece. The field suffers from reversal because of the triple reflection, (from mirror, to declination axis diagonal, to polar axis diagonal,) but despite this Mr. Fernald can observe 40 variable stars an hour. Before starting to observe he lays out his night's program so that he can jump from star to star, using the differences in R.A. and Declination to find each successive star. He has observed 180 hours during the year.

Heating elements to keep off dew are not needed for the diagonal located on the declination axis, but they are desirable for the polar axis diagonal and the eyepiece. Mr. Fernald does his sun-spot counting with an interchangeable uncoated diagonal. Mr. Fernald's mirror is attached to its tube by bayonet sockets and he removes it when not observing. He does not find any loss of collimation from this practice, but he stated that it is very necessary to have both the diagonal mirrors fully adjustable and very firmly held by their mountings, especially the one on the declination axis.

87 Fern Circle,
Waterbury 69,
Connecticut.

PLATE IV



An Interesting Stone Sun-dial, from the North of Scotland. W. S. McClenahan.

AN INTERESTING SUN-DIAL

By W. S. McClenahan

(With Plate IV)

RECENTLY a very interesting sun-dial was brought to the Observatory by Mr. C. R. McIntyre of Martintown, Ontario. It is an heirloom that has been in his family for some time, having been brought to this country by some of his ancestors named Ross, who came from the north of Scotland. Intending to have it mounted in his garden he was puzzled to know how to do it, consequently he brought it to an old friend of his, Mr. J. P. Henderson, at the Dominion Observatory, to learn how to set it up.

The sun-dial has been cut from a block of soapstone approximately one foot square, by three inches thick, and in its present shape weighs between thirty and forty pounds. The hours are marked on the surfaces as indicated in the picture, two sets of figures being engraved in the stone, one series marked 7, 8, 9, 10, 11, and the second set, either above or below the other, marked 1, 2, 3, 4, 5. Each division is graduated to a quarter hour. All four inner surfaces are engraved and at first it looked as if it could be mounted in four different positions. It has to be set up so that the top is in a plane at right angles to the earth's axis and the shadows cast by the inner solid corners, which must be parallel to the earth's axis when properly mounted, indicate the time of day. It can be mounted on a post or pier, the slope being (90° — latitude) with the horizontal. A pin inserted in the centre at right angles to this surface and pointed towards the pole would then carry the sun-dial. There is a hole drilled in the base for this purpose. If the above requirements have been met the sun-dial would be ready for use.

The building of a pier having the proper slope for the sun-dial so that the pin points to the north pole is the main task. Once this is done the sun-dial can be set in place and turned so that the top edges are horizontal. Knowing the local mean time and the equation of time also affords a check.

The face showing in the picture would face east and the numbers tell the morning hours, the edge to the left determining the figures

7, 8, 9, 10, 11, while the right edge fixes the hours 1, 2, 3, 4, 5. This side could not face south because then the right edge would refer to 7, 8, 9, 10, 11, and the angles from this edge to 11, 10, etc., are not 15°, 30°, etc., as they should be.

An illustration and description of a similar shaped dial appears in "The Book of Sun-Dials" by Eden and Lloyd, and mention is there made of a valuable paper by Mr. Ross on Scottish sun-dials given before a Scottish Society in 1891. Apparently there was a great sun-dial making period in Scotland beginning in the sixteenth and lasting to the eighteenth century. Many fine ones are illustrated in the above-mentioned book.

This is a very simple type of dial to calibrate. All that is necessary is some means of marking off 15° angles from the shadow casting edges, and it has the advantage that it can be mounted in any latitude.

Dr. T. L. Tanton of the Geological Survey and the immediate past president of the Ottawa Centre, was interested and identified it as soapstone, which is common not only in Scotland but in Canada also. Many of us were familiar with it in our early school days in the form of slate pencils. It is a stone containing varying amounts of talc and is not difficult to cut. None of the observatory staff had seen one like it before, and it was thought a short description would be of interest to the Journal readers. There may be other sun-dials hidden away. They do add interest to any garden.

Dominion Observatory,
Ottawa.
December 13, 1945.

CORRECTING WATCH TIME BY WATCH VIBRATIONS*

By E. M. Tingley

A good watch may be made to run faster or slower by balancing it, face horizontal, on a bit of rubber about 1/32-inch thick cut from a live elastic rubber band.

A button of rubber ⅛-inch round or square will cause the watch to gain ten to twenty seconds overnight or in about ten hours. It may require several attempts to balance the watch horizontally on such a small button. The guard or chain must be removed. The oscillations or shimmy of the whole watch due to the reactions of its balance wheel should be plainly visible.

A similar rubber support about 3/16-inch square will cause the watch to lose about six seconds in ten hours.

It is interesting to view very small oscillations with a microscope using a magnification of 30 to 60 diameters. Place the watch with its rubber support on a glass slide for convenience in centering it on the microscope stage and use the fine scratches on the pendant as targets. Also watch oscillations may be projected greatly magnified on a screen with the familiar laboratory mirror and lamp.

Using the cut-and-try method with rubber supports a good watch may be maintained within ten seconds of correct time indefinitely by repeating the correcting operations occasionally as required, without opening the case.

Opening the watch case for the usual methods of correcting watch time is objectionable as dust and moisture may be admitted. It is also difficult to adjust the registration between the second hand and the minute hand.

There are at least 25 other ways mechanical, with their variations, of allowing a whole watch to oscillate so as to change its time

*Reprinted from *School Science and Mathematics*, June, 1944.

rate but the rubber button support is one of the simplest. Possibly some of the other ways could be produced in convenient and commercial form.

One bifilar pendulum suspension of fine threads (56-3 nylon), when properly tuned, allows about fifteen degrees arc of vibration in the plane of the dial, an astonishing amount.

All the above applies to a 16-size level set watch of railway quality. It is probable that like performances may be obtained with 12 or 18-size watches by trial, but probably not with very small watches.

After experimenting with various methods of free oscillations one becomes suspicious that the fabric or the surface on which a watch lies at night, or the hook on which it hangs, might affect its timekeeping.

The action of a watch on a support permitting oscillations due to the reaction of its balance wheel is well known to horologists. Oscillations of a whole watch are often observed when the watch hangs on a simple hook. This performance is known in mechanics as the action of two coupled oscillatory bodies and it is quite difficult of mathematical analysis. It is often illustrated experimentally in physics by two coupled pendulums.

The NBC precision time signals, and the continuous time signals on 2.5, 5, 10, and 15 megacycles, from the Bureau of Standards, afford reliable standards for maintaining correct watch time.

It is best to regulate a watch to run fast then slow it by vibrations as required. Artgum cut capstan-shape and half an inch high is a good vibrator and is not so easily lost as a bit of rubber band.

Interesting books:

The Science of Clocks and Watches. Dr. A. L. Rawlings, 1944, Pitman Publishing Corporation.

Mechanical Vibrations. J. P. Den Hartog, 1940, McGraw-Hill Book Company.

221 N. Cuyler Ave.,
Oak Park, Illinois.

IN MEMORIAM—CYRIL GEOFFREY WATES

By J. W. Campbell

HOW often it has been said of an active man after he has passed on "it seems impossible to think of him as dead." It is that way with Mr. Wates.

Until early in 1939 he was a man of strong physique, but at that time he was overtaken by a heart condition. A period of several weeks was spent in the hospital and a good recovery was made, although the former tempo of life was not again possible. Following this he enjoyed moderately good health until about a year ago, and then a decline set in. But crisis after crisis went by and early this year he appeared to have regained a lease on life. After months of absence from his office he returned during the last week of January for a half of each day. On Saturday, February 2nd, he seemed much improved and his friends noted more of his old-time sparkle. But in the evening of that day, in the quiet of his own home, he suddenly collapsed and it was all over in a few minutes.

Mr. Wates had a varied and rich experience. A telephone engineer by profession, he had many hobbies. He was a gifted writer and speaker. He had a strong leaning to scientific fiction, but he also wrote verse and composed music. Besides he was a lover of the mountains, of the sky, and in fact of everything pertaining to the great outdoors.

For many years he was a member of the Edmonton Centre of the Royal Astronomical Society of Canada and he gave it unstinted service. He was a frequent contributor to the programme as main speaker, but he also gave a short talk on the Handbook at almost every meeting. And members will recall with what pleasure he brought to meetings articles or poems on astronomical topics. He was President of the Centre in 1938 and at his death he was entering his second year as a member of General Council. Perhaps,

however, he was best known to members of the Society at large as the winner of the Chant Medal just two years ago, the award being largely for the construction of a 12.5 inch telescope which he donated to the university.

His interest in astronomy was very real but perhaps the greatest hobby interest of his life was the mountains, and to know something of his interest in mountaineering is to get a greater insight into the character of the man himself.

In the *Canadian Alpine Journal* of 1941 there appeared an address which he had given on *Men, Mountains, and Motives*, and it is the story of what the mountains had meant to him. It is told in his delightfully simple and charming style, and the narrative is rendered impersonal by being given as the experiences of "my friend."

The evolution is interesting. He was in succession impressed by the mountains for their mystery, their friendliness, their aloofness, their beauty, their grimness, their difficulty, their sweetness, and then in the course of his mountaineering experience by the companionship, the sharing and the fun which they engendered. This joy of sharing was so characteristic of his life. He loved to lead beginners to vantage points from which to view scenes of mountain grandeur he had previously enjoyed, and later with his telescope he loved to share with the inexperienced the beauties of the sky which are otherwise invisible.

In 1938 he was elected President of the Alpine Club of Canada. Many were the years that he had participated in ardent activities at the annual camps, and none but his closest friends can realize how great was the disappointment when by virtue of his illness in the winter of 1939 he was to be unable to go to the camp that year of his presidency and play his usual active role. Yet he felt no bitterness about his fate, and he wrote:

> My friend is drawing near to the autumn of his life. No more for him the lonely bivouac, the splendour of the dawn on windy heights, the chip of axe on brittle ice, the drowsy hour on sunny summit. Some day the tapestry will be folded up and laid aside, but still the loom of the mountains continues to weave thread after thread. Life holds, as for all men, its disappointments and its sorrows, but the great hills weave the thread of Comfort. In these days of strife

and hatred it is easy to sink into an indifferent materialism, but the mountains weave the thread of Worship. The roar of battle echoes across the world but the mountains weave the thread of Peace.

Quite truly, his was the serenity of the distant hills and of the silent starry sky.

> Whoso the summit doth once attain
> Shall never be quite the same again.

As the funeral procession left the little chapel there came from the organ strains of the music which he had composed for an Indian Prayer. That prayer had become a theme song of Alpine meetings, at which he had so often led in the singing.

> Be with me O Great Spirit
> When I climb the lofty mountains;
> Be with me when I cross the sun-scorched valleys;
> Turn Thou Thy face to me.
> With a smile like the sun at morning;
> Keep Thou Thy hand in mine, until Thou leadest me
> Into the Land of the Setting Sun.

University of Alberta,
Edmonton, Alta.

REVIEW OF PUBLICATIONS

Electrons in action, by James Stokley. 320 pages, 5½ × 8¼ inches, 32 plates. New York, Whittlesey House, McGraw Hill Book Company, Inc., 1946. Price $3.00.

With the gradual post-war removal of secrecy restrictions on research work, a great opportunity is presented to scientists to modernize the scientific knowledge of the public. James Stokley, with years of science interpretation as a writer in Science Service, as Director Fels Planetarium, and more recently in the General Electric Research Laboratory, makes excellent use of this opportunity.

In a clear and pleasant manner the reader is led through descriptions of some of the principles of electron physics. Then a wide variety of applications of these principles to scientific apparatus are described, frequently with diagrams. Few fields of modern electrical instruments and processes do not make use of electron physics, and the author, in his position at General Electric, has had a chance to select many of the more significant and interesting processes.

Radio, television and sound recording are amongst the familiar applications described. Stokley's astronomical interests are reflected in a very interesting chapter on Cosmic Electrons, dealing chiefly with solar effects on radio reception. The electron microscope, x-rays and electrons in medicine are surveyed. Industrial controls and industrial production are also briefly described. A chapter on atomic energy is followed by an appendix in which is discussed radar and navigational loran.

In a book of such a range of subjects the treatment of each is necessarily brief, but interesting. The plates supplied by a few of the largest electrical manufacturing firms, are of excellent quality. In many cases they are not well incorporated into the general text. This in some cases might be corrected in later editing by more ample descriptive footnotes to the plates.

This book will undoubtedly become deservedly popular. It is instructive and stimulating. F. S. H.

NOTES AND QUERIES

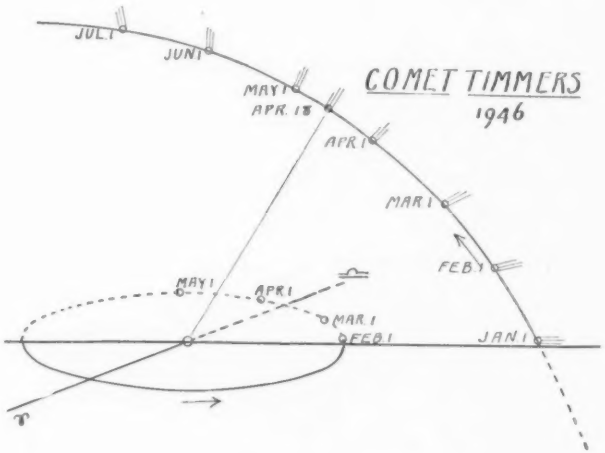
Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Comet Timmers

On February 6th a ninth magnitude comet was discovered by M. Timmers, of the Vatican Observatory. At the time of discovery it was at R.A. 9 h. 47.5m Dec. + 42° 24′. The comet was subsequently observed at many observatories. Orbits were computed by Dr. Cunningham, of the Aberdeen Proving Ground, and Miss Stahr of Wellesley. Cunningham's elements, derived from observations of February 5, 6 and 8, are as follows:

T = 1946, April 18. 820	ω = 58° 28′	(1946)
q = 1.6763 A.U.	Ω = 128 46	(1946)
	i = 72 18	(1946)

The path of the comet is shown in the accompanying diagram.



The plane of the cometary orbit is represented as lying in the plane of the paper. When on April 18th the comet is in perihelion, it will be 1.6763 units from the sun, so that it will not become a brilliant object. At its closest to the earth, in early February, its distance from the earth was just over one astronomical unit. At its brightest, in early March, it will be about 8.5 magnitude.

The ephemeris predicts the following positions (equinox of 1946):

March	17.0	7 h.	19 m.,	+ 74°.6
April	2.0	6	22	+ 77 .9
April	18.0	6	01	+ 80 .3
May	4.0	6	28	+ 83 .0
May	20.0	8	41	+ 85 .5
June	5.0	12	48	+ 84 .0

F.S.H.

ASTRONOMICAL BOOKS AT THE WINDSOR CENTRE

Our newest and very active Centre at Windsor has completed a good arrangement with the Windsor Public Libraries. The meetings of the Society are held in the Art Gallery of the Willistead Library. At each meeting the Library staff has on display a selection of books and magazines on astronomy and related sciences. Mr. E. J. Edwards, librarian of the Windsor Centre, is on duty before and after each meeting to issue any of these library books to members or visitors, on presentation of their regular Public Library cards. Books so borrowed through the Society, as well as any of the books belonging to the Centre itself, may be retained until the following meeting one month later.

Another source of congratulation to the Windsor Centre is its close liason with the Detroit Astronomical Society. The Windsor programs list the meeting dates and subjects of the Detroit Society; a number of Detroit members attend the Windsor meetings; and Windsor is able to draw on Detroit and Michigan to secure a wide range of speakers for its meetings.

F. S. H.

NOVA T CORONAE BOREALIS

This star, at R.A. 15 h. 57.4 m., Dec. 26° 04′ (1950), had a nova

outburst in 1866, at which time it rose from magnitude 9.5 to 2nd very rapidly, and within nine days was again invisible to the unaided eye. It has been mildly variable about the tenth magnitude for the past eighty years. On the morning of February 9th Armin Deutsch, of the Yerkes Observatory, noticed that this star was again bright, estimating the magnitude as 3.2. Spectra showed very wide nova-type lines, corresponding to expansion velocities of about 4,000 km. per second. On the morning of February 11th its magnitude was estimated at the Dunlap Observatory as about 3.8; due to low haze followed by clouds this magnitude is not highly accurate. Direct photographs, but no spectral observations were made, due to typical February cloudy weather here. The star apparently followed the pattern of its previous "blaze" outburst, as it was below the eighth magnitude before the end of the month.

It is interesting to note that in "The Story of Variable Stars" Campbell and Jacchia listed T Coronae Borealis as a possibly recurring nova.

F. S. H.

MEETINGS OF THE SOCIETY

AT TORONTO

December 5, 1944.—The Society met at 8:00 p.m. in the McLennan Laboratory, University of Toronto; Miss R. J. Northcott in the chair.

Four persons were elected to membership in the Society:

Mr. Lionel Kernerman, 323 Brunswick Avenue, Toronto.
Mr. Frank Knight, 635 Windermere Avenue, Toronto.
Miss Norah Snelgrove, 142 Wellesley Crescent, Toronto.
Mr. Lester E. Weaver, 47 Foxbar Road, Toronto.

Mr. H. W. Barker, Vice-Chairman of the Centre, gave a paper on "Some Ancient Astronomers." A synopsis follows:

Neolithic Man (12,000 to 10,000 B.C.), the earliest in the development of the human race to show any real intelligence, set himself to discover, if he could, something of the laws governing the movements of the sun and stars, the wandering of the planets and cause of the moon's phases. A herdsman, he was nomadic, and as he watched his flocks by night he began to look upon the stars as friends, not only to guide him in his travels but to tell him when to plant and when to garner his grain and fruit. It seems likely he also reckoned time by the successive full or new moons.

Tradition credits Egyptian priests, some thousands of years before Christ, with possessing considerable astronomical knowledge. Chinese records described observations made as far back as the 25th century B.C., and from Indian sacred books we know that some astronomical knowledge was possessed in that part of the world several centuries before this. The Chaldeans also are known to have had much information regarding the heavens as early as any of these. Much later (perhaps 800 or 1000 years ago) the Aztecs in Mexico are said to have invented practically the same instruments as the Chinese and Babylonians used and to have made similar discoveries. These countries are widely separated and there could have been no communication between them, so we may conclude independent research led thoughful men in the dawn of civilization into possession of the same facts about phenomena of the heavens.

The oldest Chaldean inscriptions would appear to be on the site of the Cushite capital of Hur (the scriptural Ur) where there is evidence that the Cushites introduced the worship of the heavenly bodies. Some 2000 years B.C. there were temples for the sun, the moon and also for Jupiter and Venus. The movements of the stars were observed and astronomical tables formed upon

which a chronological system was founded. They knew the synodical period of the moon and the length of the year and we are told they ascribed solar eclipses to their true cause and accurately calculated lunar eclipses.

When Babylon was captured by Alexander the Great, his teacher Aristotle is said to have received from Callisthenes a list of eclipses which were observed there during a period of 1903 years. To the Chaldeans also is attributed the invention of the Zodiac.

On the whole the astronomy of the early Oriental nations did little beyond furnishing tolerably exact knowledge of the motions of the sun and moon. Their observations seem to have dealt principally with eclipses, occultations and the times of rising and setting of the principal stars.

The Greeks are credited with being the first to formulate a system of astronomy. Hesiod (about 850 B.C.) mentions the Pleiades remaining invisible for 40 days, and this is just about right for his epoch and latitude. Thales (636 to 546 B.C.) made a very near approach to the correct diameter of the sun, estimated the sun's orbit, taught the sphericity of the earth and predicted an eclipse of the sun which actually took place at the time announced, this last being probably the greatest astronomical achievement up to that time. The philosophers who followed Thales advanced such theories as: (1) the moon's light is reflected from the sun; (2) the earth rotates on its axis; (3) the moon, like the earth, has hills and valleys, and some also believed that the moon was inhabited. Pythagoras said the moon's phases proved it to be spherical and not a flat disc, and belief in the spherical form of the earth seems to have been ever-present in the minds of the Greek philosophers of that age. Credit is also given to Pythagoras for discovering that the morning and evening stars are identical—none other than the planet Venus. Both Pythagoras and Aristotle taught that the planets and comets, including the earth, are in motion around the sun, but as the laws of motion and gravity were unknown, such ideas met with little general acceptance—"for everything would fly from the surface of the spinning globe."

After Aristotle, Egypt seems to have become the centre of things astronomical. Between 305 and 43 B.C. the Ptolemy dynasty ruled Egypt and some of these kings did much to advance education and encourage scientific research. The first Ptolemy established the Alexandrian Museum which contained not only a library but a college and an observatory. Among other things the positions of many of the fixed stars were determined and the paths of the planets carefully plotted. In course of time Alexandria was able to present to the world a system of theoretical astronomy with a plan covering the celestial movements.

To Hipparchus, an Athenian ruler of the second century B.C., belongs the honour of being called the "Father and Founder of Real Astronomy." Competent critics place him far above any other astronomer of the ancient world. He first attempted a systematic classification of the stars and determined their magnitude; he calculated very accurately for his time the length of the tropical year; and he also made a representation of the heavens on the surface of an

artificial globe—this might be called the first planetarium. He catalogued no less than 1,080 stars and therby rendered a distinct service to astronomy.

Our knowledge of his work comes principally through Claudius Ptolemy (not to be confused with the line of Egyptian kings) who flourished in Alexandria in the second century of the Christian era, and became best known as founder of the Ptolemaic system, based largely on the theories of Hipparchus, which placed the earth in the centre of the universe. This theory was generally accepted right up to the time of Copernicus. He was the first to use the terms "latitude" and "longitude" and issued a number of proofs that the earth is a globe.

The overthrow of ancient civilization and the conflict for supremacy which for centuries agitated the various nations introduced a period when the liberal arts were neglected but the Arabs, from about the middle of the eighth century, gave some attention to astronomical research. Following the work of Ptolemy, they made considerable progress with his theories and discoveries as a basis, and on the whole their observations showed greater accuracy than those of the Greeks. And interest in astronomy gradually found its way to far-distant lands.

Mr. C. A. Crook followed with a short paper on "Points and Circles of Reference and Systems of Coördinates," in which he defined some of the terms used in astronomy, such as zenith, nadir, horizon, meridian, prime vertical, altitude, zenith distance, azimuth, celestial poles, pole of rotation, celestial equator and hour circles, declination and hour angle, ecliptic, equinox, solstices, colure and right ascension.

February 5, 1945—The Society met jointly with the Toronto Field Naturalists' Club in the Theatre of the Royal Ontario Museum at 8.15 p.m., with Prof. T. F. McIlwraith, president of the Naturalists' club, and Mr. H. W. Barker, Chairman of the Toronto Centre, R.A.S.C., as joint chairmen. Welcoming the Centre, Prof. McIlwraith expressed appreciation of the Naturalists' Club for the opportunity of meeting with a fellow organization. In reply, Mr. Barker pointed out that most members of the Society were interested in astronomy "as a specialized species of naturalist" and not as professional astronomers.

Miss R. J. Northcott, Past Chairman of the Centre, gave a brief account of the planets—Venus, Saturn and Jupiter—visible in the evening skies during the month. Prof. McIlwraith pointed out that Miss Northcott had arranged a display of astronomical photographs in the lobby outside the lecture hall.

Mr. W. E. Knowles Middleton of the Meteorological Service of Canada addressed the meeting on "Light and Colour in the Air." The subject had nothing to do with weather forecasting, he said, but dealt with meteorological optics. Some of the phenomena produced when light gets bounced about in the atmosphere were very beautiful. "Why is the sky blue—and not green or pink?" he asked. Behaviour of light in the atmosphere is conditioned by the composition of the atmosphere: impurities in the air cause the varying phenomena. Some of those described follow:

(1) Phenomena produced by refraction in air of varying density, including mirages, looming, distortion of the rising and setting sun, and twinkling of stars. "These phenomena are much more common than generally realized. When you look for them, you notice them."

(2) Phenomena produced by molecular scattering. The reason for the sky being blue has puzzled people from antiquity. The answer is that the molecules of the atmosphere scatter blue light more than red light. "We should think of the blue of the air, not the blue of the sky."

(3) Phenomena produced by scattering from small solid particles. This group includes the twilight colours. The sun at zenith is equivalent to 9,600 foot-candles or 465,000 zenithal full-moons. Twilight at sunrise or sunset is the equivalent of 33 foot-candles or 1,598 full-moons. At the beginning or end of civil twilight, when the sun is six degrees below the horizon, the light is 0.40 foot-candle or 19 full-moons. The full moon at zenith is equal to 0.02 foot-candle and starlight to 0.00008 foot-candle or 0.004 full-moon.

(4) Phenomena produced by diffraction include corona, glory, heiligenschein and bishop's ring. The corona is a brownish ring around the moon, seen especially when there is alto-cumulus cloud, and is produced in the same manner as the rings seen around street lamps when viewed through a frosty window. The corona is also seen around street lamps on frosty nights. Bishop's ring is the phenomenon caused by fine particles in the atmosphere following great volcanic eruptions.

(5) Phenomena produced by reflection and refraction in water drops: example, the rainbow. The rainbow cannot be seen if the sun is more than 42° above the horizon, although partial bows may appear when the sun is slightly higher.

(6) Phenomena produced by reflection and refraction in ice crystals: example, haloes. These include the 22° ring seen around the sun with a sharp, reddish inner edge; also sun-dogs, and the 46° halo produced when the light is refracted through a 90° angle.

Mr. Middleton said that atmospheric optics might provide an interesting field of observation for both amateur astronomers and naturalists. "The landscape is not just trees, flowers, streams—but also includes the sky and the air around us. One's enjoyment of the landscape can be enhanced by looking for these phenomena in the atmosphere and you will sometimes be rewarded by seeing beautiful and unusual effects which are never noticed unless you specially look for them," he concluded.

Mr. Barker thanked the speaker on behalf of both societies, and the meeting was then adjourned.

February 20, 1945—The Society met at 8:00 p.m. in the McLennan Laboratory, University of Toronto: Mr. H. W. Barker in the chair.

Six persons were elected to membership in the Society, viz:

Mr. W. H. Bell, Richmond Hill, Ont.

Mr. A. E. Byrne, 45 27th Street, Long Branch, (Toronto 14).
Mr. John L. Horwood, 361 Glengrove Avenue West, Toronto 12.
Mr. John Mair, 69a Maclean Avenue, Toronto.
Mr. G. A. McVicar, 21 Relmar Road, Toronto 10.
Mrs. H. Findlay Walton, 17 Spadina Road, Toronto.

T. R. Loudon, professor of civil engineering and aviation in the University of Toronto, addressed the Society on "Jet Propulsion." Engineers today, he said, think they see the limit of efficiency of the internal combustion engine and propeller, and are turning to jet propulsion as a means of attaining greater flying speed. The idea of jet propulsion is not new—it is based on the old principles of conservation of momentum. In contrast to present-day aircraft, jet propelled machines theoretically could operate in a vacuum. Jet propulsion simplifies many of the mechanical problems found in the present engine and propeller but does not provide any solution to the problems involved in flight at supersonic speed. As 500 miles an hour is approached, a new set of laws applies; the resistance or drag goes up enormously and the lift on the wings drops.

In the turbo-jet system, the liquid fuel must be carried along, but the air which goes into the fuel mixture is taken from the surrounding atmosphere. The rocket is a specialized form of jet propulsion but it has to carry *all* the fuel required.

The speaker pointed out that aviation research is very expensive requiring, for example, huge wind tunnels that only the wealthier nations can afford. Jet propulsion experimentation was even more costly, he added. Nevertheless, he predicted that within a short time jet-propelled planes would fly from Toronto to London, England, in four hours. "Research now being conducted at Leaside (a Toronto suburb) into jet-propelled aircraft is going to result in one of the biggest things in aviation," he declared.

"We are rather prone in Canada to attribute everything big to someone else; we haven't enough confidence in ourselves." Prof. Loudon added in pointing out that many notable achievements in aviation were the work of Canadians. The ailerons which permit an aircraft to bank were the invention of two Canadian pioneers, F.W. Baldwin and J. T. McCurdy. The mining industry of the Dominion owed much to aviation, especially to the fliers who took heavy equipment by ski-equipped planes into areas inaccessible by any other means. Canadian pilots and flight engineers knew more about winter operation of aircraft than any other nation, he stated.

In reply to a question from the audience, Prof. Loudon said he doubted the probability of interplanetary flight. "And if you did get to the moon or Mars, how are you going to get back?" he asked.

F. L. Troyer,
Recorder.

The Royal Astronomical Society of Canada

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